Gas geochemistry of the hot spring in the Litang fault zone, Southeast Tibetan Plateau

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Abstract:

The southeast Tibetan Plateau is a region with high level seismic activity and strong hydrothermal activity. Several large (7.5 > M > 7) historical earthquakes have occurred in the Litang fault zone (LFZ), eastern Tibetan Plateau since 1700. Litang *Ms* 5.1 earthquake occurred On Sept 23, 2016, indicating the reactivation of the LFZ. This study was undertaken to elucidate spatial-temporal variations of the hot spring gas geochemistry along the LFZ from Jun 2010 to April 2016. The chemical components, He, Ne and C isotropic ratios of bubbling gas samples taken from 18 hot springs along LFZ were investigated. Helium isotope ratios ($^3He/^4He$) measured in hot springs varied from 0.06 to 0.93 Ra (Ra=air $^3He/^4He=1.39\times10^{-6}$), with mantle-derivd He up to 11.1 % in the LFZ (assuming R/Ra=8 for mantle) indicated the fault was a crustal-scale feature that acts as a conduit for deep fluid from the mantle. CO_2 concentrations of the majority of hot spring gas samples were ≥80 vol.%, $CO_2/^3He$ ratios varied from 1.4 to 929.5×10^{10}, and $\delta^{13}C_{CO2}$ values varied from −19.2‰ to −2.3‰ (vs. PDB). The proportions of mantle-derived CO_2 varied from 0 to 1.8%. Crustal marine limestone was the major contributor (>75%) to the carbon inventory of the majority of hot spring gas samples. Before Litang *Ms* 5.1 earthquake, the $^3He/^4He$ ratios obviously increased in the Heni spring from May 2013 to Apr 2016. The geographical distribution of the mantle-derivd He decreased from east to west along 30°N in the southeast Tibetan Plateau relative to a corresponding increase in the radiogenic component. The gas geochemical data suggested that the upwelling mantle fluids into the crust play an important role in seismic activity in the strike-slip faults along 30°N in the southeast Tibetan Plateau.

Key Words: Gas geochemistry, Earthquake, Hot spring, He isotopic ratios, Litang fault zone, Tibetan Plateau